BK PRECISION

SERVICE MANUAL

MODEL 1610 & 1630
DC POWER SUPPLY

MP MASTER
MA33149

BK PRECISION

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must sometimes be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. There is little danger of electrical shock from the dc output of this power supply. However, there are several other possible test conditions using this power supply that can create a high voltage shock hazard:
   a. If the equipment under test is the "hot chassis" type, a serious shock hazard exists unless the equipment is unplugged (just turning off the equipment does not remove the hazard), or the precautions of step 8 are observed.
   b. If the equipment under test is "powered up" (and that equipment uses high voltage in any of its circuits), the power supply outputs may be floated to the potential at the point of connection. Remember that high voltage may appear at unexpected points in defective equipment. Do not float the power supply output to more than 500 volts peak with respect to chassis or earth ground.
   c. If the equipment under test is "off" (and that equipment uses high voltage in any of its circuits under normal operation), discharge high-voltage capacitors before making connections or tests. Some circuits retain high voltage long after the equipment is turned off.
2. Use only a polarized 3-wire ac outlet. This assures that the power suppply chassis, case, and ground terminal are connected to a good earth ground and reduces danger from electrical shock.
3. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
4. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
5. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet.
6. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
7. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.
8. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result from connecting an earth ground lead of a test instrument to a "hot chassis". To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B & K-Precision** Model TR-110 or 1604 Isolation Transformer, or Model 1653 or 1655 AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.
9. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

SERVICE MANUAL

for

BK PRECISION

MODEL 1610 & 1630
DC POWER SUPPLY

This service manual is intended for use by qualified electronics technicians only. To avoid electrical shock, do not perform servicing unless you are qualified to do so.

BK PRECISION

FACTORY SERVICE OPERATIONS
6470 West Cortland Street
Chicago, Illinois 60635
(312) 889-1448

Please use this address for parts orders or technical inquiries

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REFERENCE PUBLICATIONS

	B&K-Precision Publication No.
Model 1610/1630 Instruction Manual	480-492-9-001
Model 1610 Schematic Diagram & Parts List	499-329-9-001
Model 1630 Schematic Diagram & Parts List	499-328-9-001

SPECIFICATIONS

	MODEL 1630	MODEL 1610
OUTPUT VOLTAGE	0 to 30 VDC, coarse and fine adjustment	0 to 30 VDC, coarse and fine adjustment
OUTPUT CURRENT HI Range LO Range	 0 to 3 A 0 to 1.5 A	 0 to 1 A 0 to 0.5A
CONSTANT VOLTAGE OPERATION		
Voltage Regulation Line (110-130 V) Load (no load to full load)	 ≤ 0.02% + 2 mV ≤ 0.02% + 3 mV	 ≤ 0.03% + 2 mV ≤ 0.04% + 3 mV
Recovery Time	≤ 200 µs typical	≤ 200 µs typical
Ripple Voltage Peak-to-Peak RMS	 ≤ 2 mV ≤ 1 mV	 ≤ 3 mV ≤ 2 mV
Temperature Coefficient 0° to +35° C	5 mV/° C typical	10 mV/° C typical
CONSTANT CURRENT OPERATION		
Adjustable Current Limits	5% to 100% (0.15 A to 3 A)	5% to 100% (0.05 A to 1 A)
Current Regulation		
Line (110-130 V)	≤ 5 mA typical ≤ 9 mA maximum	≤ 6 mA typical ≤ 12 mA maximum
Load	≤ 5 mA typical ≤ 9 mA maximum	≤ 5 mA typical ≤ 12 mA maximum
Current Ripple	≤ 3 mA typical	≤ 2 mA typical
METERING		
Voltmeter Range Accuracy	 0 to 32 V ±2.5%	 0 to 32 V ±2.5%
Ammeter HI Range LO Range Accuracy	 0 to 3.2 A 0 to 1.6 A ±2.5%	 0 to 1.04 A 0 to 0.52 A ±2.5%
POWER REQUIREMENTS	110/120/220/240 VAC ±10%, 50/60 Hz	110/120/220/240 VAC ±10%, 50/60 Hz
POWER CONSUMPTION	Approx. 170 W or less at full load	Approx. 60 W or less at full load

	MODEL 1630	MODEL 1610
PROTECTION	Reverse polarity protection, Current limiting	Reverse polarity protection, Current limiting
TEMPERATURE RANGE Operation Storage	 0° to +40° C -15° to +70° C	 0° to +40° C -15° to +70° C
DIMENSIONS (HxWxD)	172 x 119 x 305 mm 6-3/4 x 4-11/16 x 12"	172 x 119 x 305 mm 6-3/4 x 4-11/16 x 12"
WEIGHT	11 lb	8 lb
ACCESSORIES SUPPLIED	Hook-Up Leads, 1 red, 1 black Spare Fuse Instruction Manual Schematic Diagram & Parts List	Hook-Up Leads, 1 red, 1 black Spare Fuse Instruction Manual Schematic Diagram & Parts List

CIRCUIT DESCRIPTION

Refer to Fig. 1 for a block diagram analysis of the power supply.

INTRODUCTION

The power supply consists of an AC input circuit and transformer, a bias supply consisting of a rectifier and filter, reference voltage source, a main regulator circuit consisting of the main rectifier and filter, a series regulator, a current comparator, a voltage comparator, a reference voltage amplifier, an instant overload protection circuit and relay control circuit.

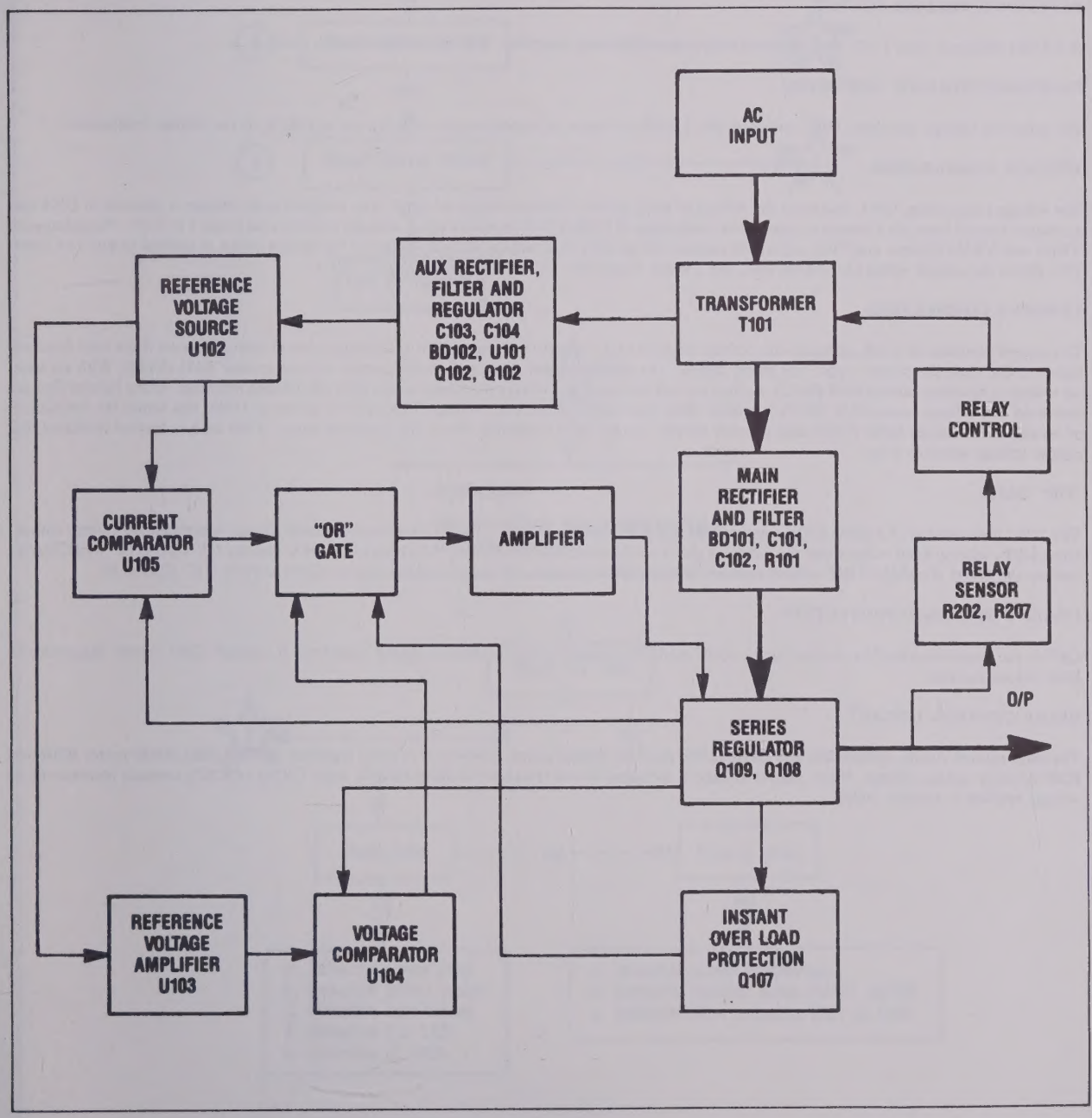


Fig. 1 BLOCK DIAGRAM

AC INPUT CIRCUIT AND TRANSFORMER

Single phase input power is applied through transformer T101 to the main and Auxiliary rectifier circuits.

MAIN RECTIFIER AND FILTER

One of the secondary windings of power transformer T101 applies an AC voltage to rectifier circuits in the power supply. Bridge rectifier BD101 is the DC source for the 30-Volt output; C101, C102 are the filter capacitor.

AUXILIARY RECTIFIER AND FILTER

Auxiliary rectifier BD102 provides a bias voltage filtered by capacitor C103, C104 for the pre-regulator U101, Q101, Q102, that provides a regulator voltage for other circuits.

REFERENCE VOLTAGE SOURCE

A 2.5-Volt reference from U102 is applied to U103, reference voltage amplifier, and current comparator U105.

REFERENCE VOLTAGE AMPLIFIER

The reference voltage amplifier, U103, increases the 2.5-Volt reference to approximately 10-Volts and applies it to the voltage comparator.

VOLTAGE COMPARATOR

The voltage comparator, U104, compares the voltage of pin 2 to the reference voltage of pin 3. Any resulting error voltage is detected in U104 and an output current from pin 6 is used to change the conduction of Q108 (Q109) to restore equal voltages between pins 2 and 3 of U104. Potentiometers VR101 and VR102 (Coarse and Fine) adjust the output voltage level by changing the proportion of the output which is applied to pin 2 of U104. This forces the output voltage to change until pin 2 again equals the 10-Volt reference voltage at pin 3.

CURRENT COMPARATOR

The current comparator, U105, compares the voltage of pin 2 to the reference voltage of pin 3. Constant current limiting occurs if the load demands more current than the power supply can safely deliver. The bias voltage is developed across current sensing resistor R131 (R132). With no load, no voltage is developed across R131 (R132). As load current increases, the voltage developed across R131 (R132) also increases. At the current limiting threshold the voltage across R131 (R132) is greater than that from the reference voltage. Through the action of U105, this limits the conduction of series pass transistor Q108 (Q109) and prevents output current from increasing above this threshold value. If the load is further increased, the output voltage starts to drop.

"OR" GATE

The "OR" gate consists of a diode D103, a zener D104 and both transistor Q105, Q106. With normal constant voltage operation, the current comparator, U105, will not limit current and the output is plus volts (approximately 12 Volts), which turns on Q105 and the C.V LED is lit. When current reaches the preset threshold, U105 output voltage becomes minus (approx. 12 Volts), which turns on Q106 and the C.C. LED is lit.

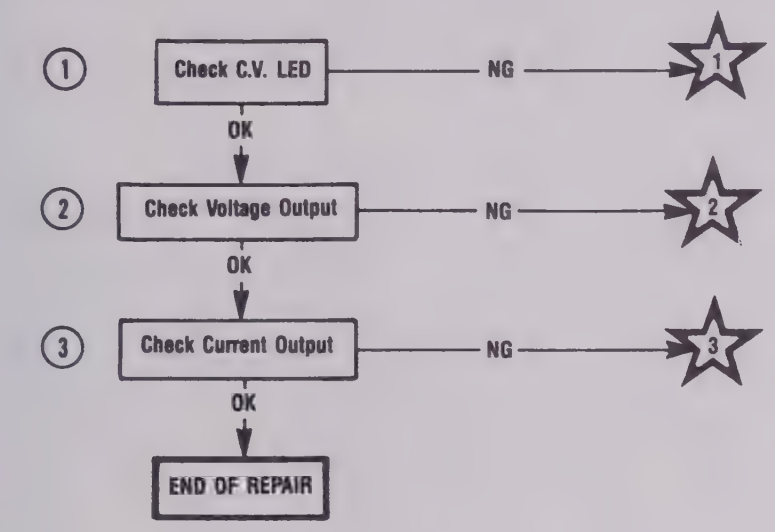
INSTANT OVERLOAD PROTECTION

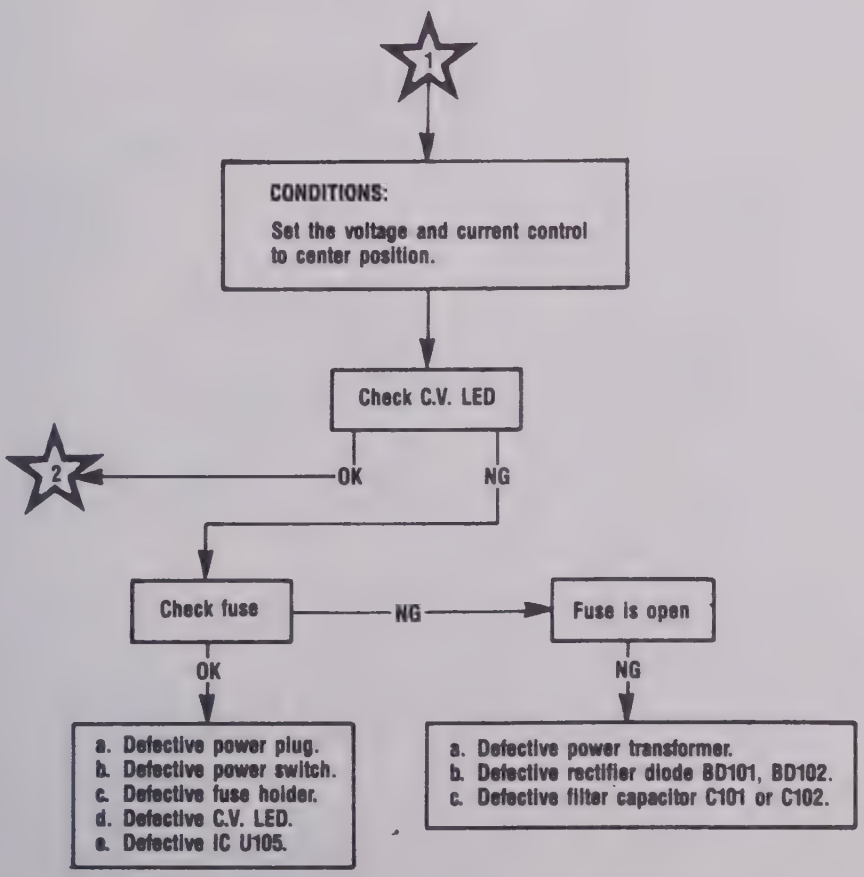
Q107 is the instant overload protection circuit. Q107 turns on instantly upon overloaded output condition. It controls Q103 current magnitude to limit output current.

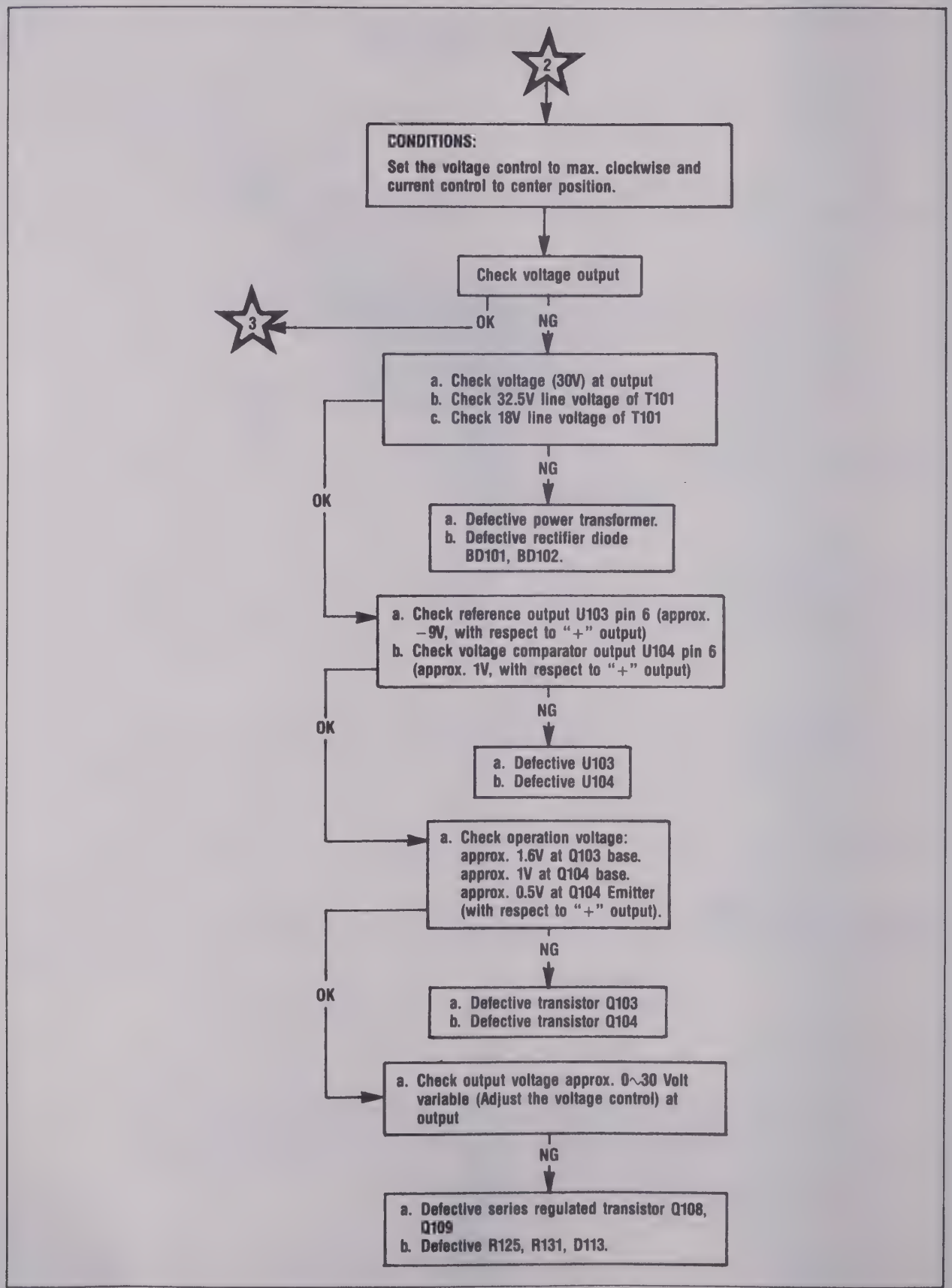
RELAY CONTROL CIRCUIT

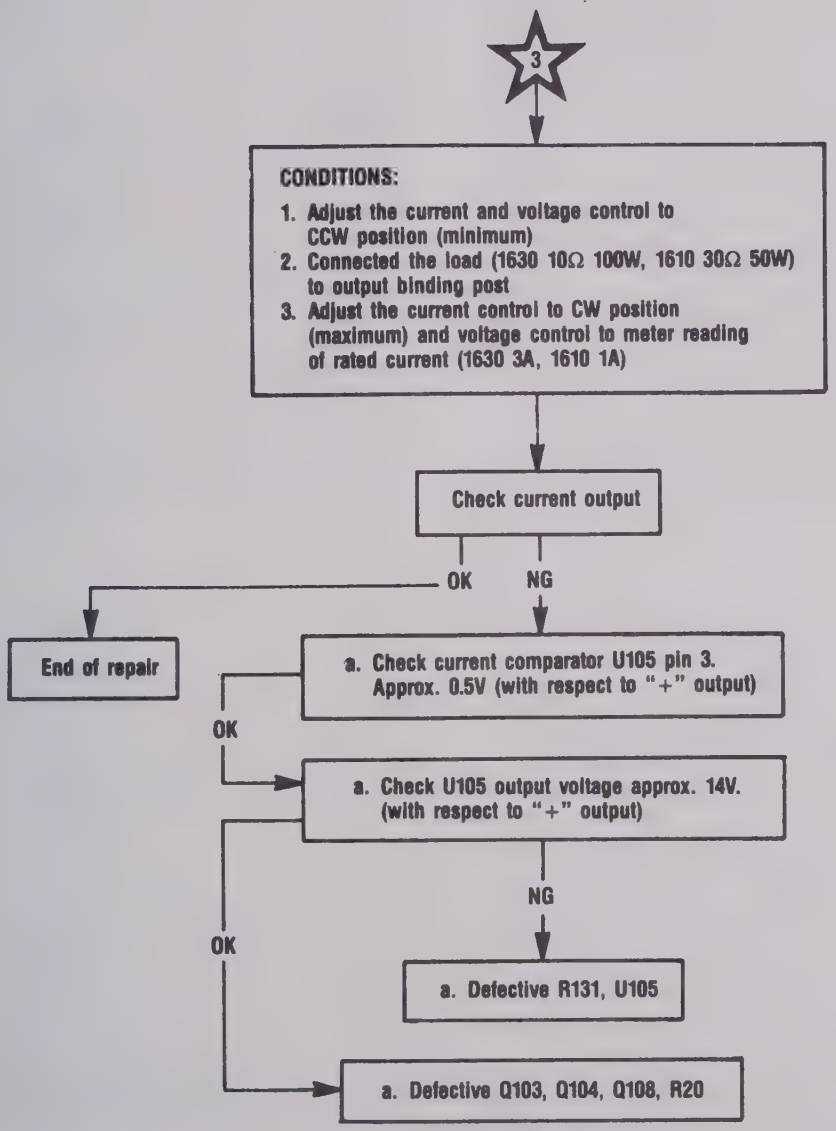
The relay control circuit, Q201/Q202 and Q203/Q204, provides limited power dissipation in series regulator (Q108, Q109). Relay sensor R202 and R207 monitor output voltage. When output voltage is increased to the threshold of Q201 (Q203), relay CR201 (CR202) contacts increase the ac voltage applied to rectifier BD101.

TROUBLESHOOTING






2
CONDITIONS:
Set the voltage control to max. clockwise and current control to center position.
Check voltage output
3
OK
NG
a. Check voltage (30V) at output
b. Check 32.5V line voltage of T101
c. Check 18V line voltage of T101
NG
OK
a. Defective power transformer.
b. Defective rectifier diode BD101, BD102.
a. Check reference output U103 pin 6 (approx. −9V, with respect to "+" output)
b. Check voltage comparator output U104 pin 6 (approx. 1V, with respect to "+" output)
NG
OK
a. Defective U103
b. Defective U104
a. Check operation voltage:
approx. 1.6V at Q103 base.
approx. 1V at Q104 base.
approx. 0.5V at Q104 Emitter
(with respect to "+" output).
NG
OK
a. Defective transistor Q103
b. Defective transistor Q104
a. Check output voltage approx. 0∼30 Volt variable (Adjust the voltage control) at output
NG
a. Defective series regulated transistor Q108, Q109
b. Defective R125, R131, D113.


3
CONDITIONS:
1. Adjust the current and voltage control to CCW position (minimum)
2. Connected the load (1630 10Ω 100W, 1610 30Ω 50W) to output binding post
3. Adjust the current control to CW position (maximum) and voltage control to meter reading of rated current (1630 3A, 1610 1A)
Check current output
OK
NG
End of repair
a. Check current comparator U105 pin 3. Approx. 0.5V (with respect to "+" output)
OK
a. Check U105 output voltage approx. 14V. (with respect to "+" output)
NG
OK
a. Defective R131, U105
a. Defective Q103, Q104, Q108, R20

MAINTENANCE

WARNING

The following instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so.

FUSE REPLACEMENT

If the fuse blows, the CV or CC indicators will not light and the power supply will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with a fuse of the correct rating as listed below. The fuse is located on the rear panel.

MODEL	OPERATION	FUSE VALUE
1610	110/120 V 220/240 V	1 A 0.5 A
1630	110/120 V 220/240 V	3 A 1.5 A

Table 1. Fuse Values.

LINE VOLTAGE CONVERSION

The primary winding of the power transformer is tapped to permit operation from 110, 120, 220, or 240 VAC, 50/60 Hz line voltage. Conversion from one line voltage to another is done by a simple wiring change as shown in Fig. 1.

A label on the rear panel identifies the line voltage to which the unit was factory wired. To convert to a different line voltage, perform the following procedure:

1. Make sure the power cord is unplugged.
2. Remove the case and locate the power transformer.
3. Rewire the power transformer to the desired line voltage as shown in Fig. 1. Insulate the ends of the unused transformer tap wires.
4. A change in line voltage may also require a corresponding change of fuse value. Install the correct fuse value as listed in Table 1.
5. Replace the cover.
6. Affix a label showing the correct line voltage for the unit after conversion. Place this label directly over the factory label.

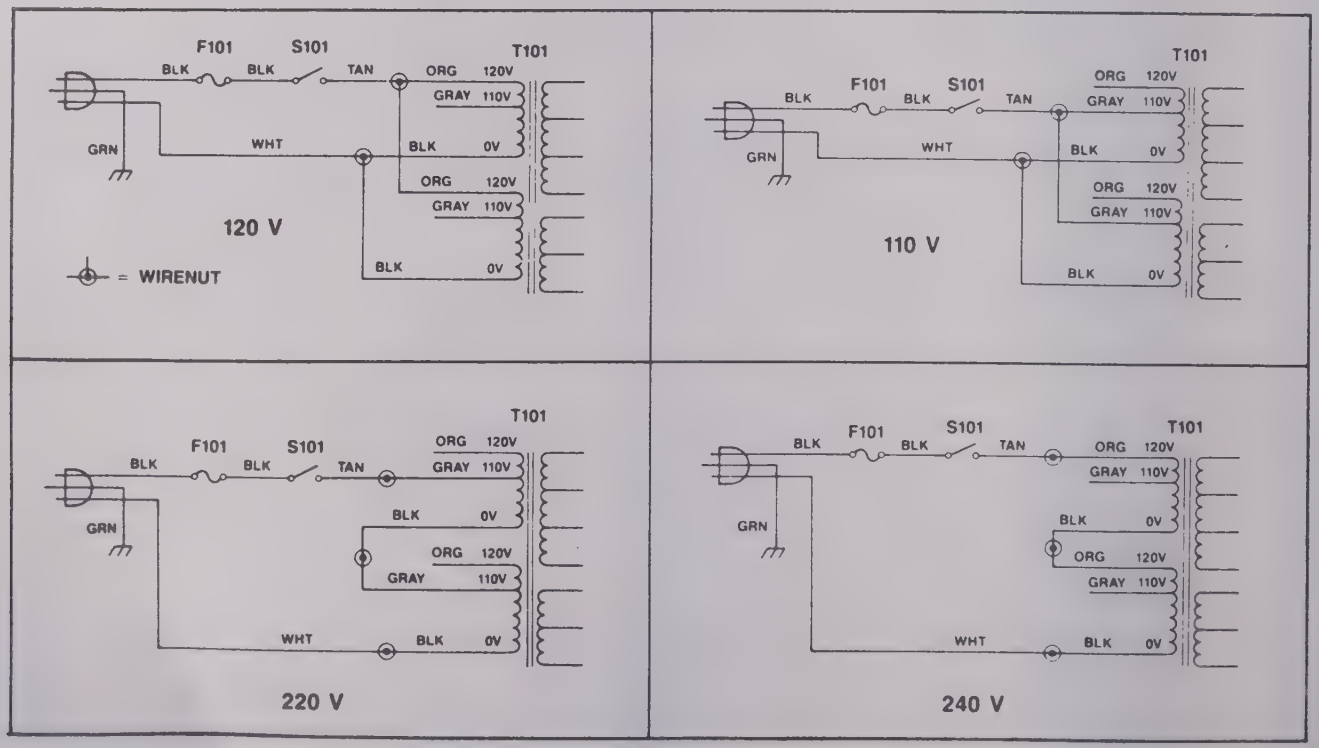


Fig. 1. Line Voltage Conversion.

ADJUSTMENTS

This unit was accurately adjusted at the factory before shipment. Readjustment is recommended only if repairs have been made in a circuit affecting adjustment accuracy, or if you have a reason to believe the unit is out of adjustment. However, adjustments should be attempted only if a multimeter with an accuracy of ±0.5% dcv or better is available (B & K-Precision Model 2807 or equivalent).

If readjustment is required, use the following procedure. Locations of the adjustments are shown in Fig. 2

1. Connect an accurate (±0.5%) external multimeter to measure the dc voltage at output terminals of the power supply.
2. Set the COARSE and FINE VOLTAGE controls to minimum (fully counterclockwise).
3. Adjust trimmer pot VR105 for a reading of 0 volts on the multimeter.
4. Turn the COARSE and FINE VOLTAGE controls to maximum (fully clockwise).
5. Adjust trimmer pot VR104 for a reading of 32 volts on the multimeter.
6. Set the COARSE and FINE VOLTAGE controls for a reading of 30.0 volts on the multimeter.
7. Adjust trimmer pot VR107 for a reading of 30.0 volts on the V meter of the power supply.
8. Set the CURRENT control to minimum (fully counterclockwise).
9. Connect the external multimeter to measure dc current at the output terminals of the power supply. Select a current range capable of measuring at least 3.2 amps for Model 1630, or at least 1.05 amp for Model 1610.
10. Set the COARSE and FINE VOLTAGE controls to a centered position.
11. Set the HI-LO switch to HI and increase the CURRENT control setting to maximum (fully clockwise).
12. Adjust trimmer pot VR106 for a reading of 3.2 amp on the multimeter for Model 1630, or 1.04 amp for Model 1610.
13. Readjust the CURRENT control for a reading of 3.0 amps on the multimeter for Model 1630, or 1.0 amp for Model 1610.
14. Adjust trimmer pot VR108 to calibrate the A meter of the power supply for the same reading as the multimeter.
15. Set the HI-LO switch to LO and readjust the CURRENT control for a reading of 1.5 amps on the multimeter for Model 1630, or 0.5 amp for Model 1610.
16. Adjust trimmer pot VR109 to calibrate the A meter of the power supply for the same reading as the multimeter.

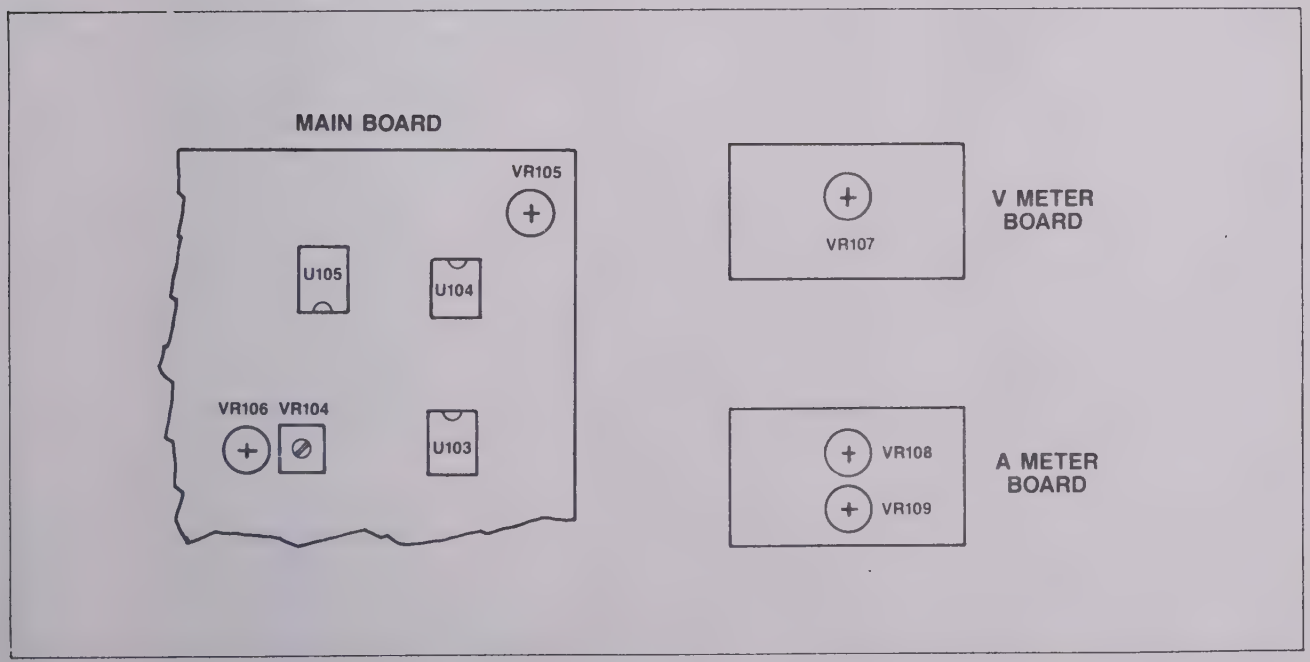


Fig. 2. Location of Adjustments.

PARTS LIST

PARTS ORDERING INFORMATION

There is a minimum charge for each invoice. Orders will be shipped C.O.D. unless previous open account arrangements have been made or remittance accompanies order. Advance remittance must cover handling, postage, or express charges. Specify model and serial number when ordering replacement parts.

ORDER REPLACEMENT PARTS FROM:

BK PRECISION
Factory Service Operations
6470 West Cortland Street
Chicago, Il 60635
Tel (312) 889-1448

MODEL 1610

SCHEMATIC SYMBOL	DESCRIPTION	B&K-PRECISION PART NO.
	RESISTORS	
	Unlisted resistors are ±5%, 1/4 W or 1/2 W. See schematic diagram for value and wattage.	
R101	4.7 kΩ ±5%, 2 W, Metal Oxide	011-002-5-472
R106	2 kΩ ±1%, 1/4 W, Metal Film	015-144-2-001
R109	10 kΩ ±1%, 1/4 W, Metal Film	015-144-1-002
R111	13 kΩ ±1%, 1/4 W, Metal Film	015-144-1-302
R112	33 kΩ ±1%, 1/4 W, Metal Film	013-076-9-014
R123	150 Ω ±5%, 2 W, Wire Wound	006-002-5-151
R131	0.5 Ω ±5%, 5 W, Wire Wound	004-222-9-001
R146	1 kΩ ±5%, 2 W, Metal Oxide	011-002-5-102
VR101	Dual 1 kΩ Potentiometer (FINE Control)	008-841-9-003
VR102	10 kΩ Potentiometer (COARSE Control)	008-841-9-002
VR103	1 kΩ Potentiometer (CURRENT Control)	008-841-9-001
VR104	2 kΩ Trimmer Pot	010-025-9-004
VR105, 106	2.2 kΩ Trimmer Pot	010-025-9-005
VR107	20 kΩ Trimmer Pot	010-025-9-003
VR108	470 Ω Trimmer Pot	010-025-9-002
VR109	100 Ω Trimmer Pot	010-025-9-001
	CAPACITORS	
C102	2200 µF, 63 V, Electrolytic	022-329-9-001
C103	470 µF, 35 V, Electrolytic	022-328-9-004
C104	220 µF, 35 V, Electrolytic	022-328-9-003
C105, 106	100 µF, 25 V, Electrolytic	022-328-9-002
C107A, 107B	2.2 µF ±10%, 35 V, Tantalum	027-074-9-001
C108	33 pF ±5%, 50 V, NP0, Ceramic Disc	031-066-9-001
C109	2.2 µF ±10%, 35 V, Tantalum	027-074-9-001
C111	0.01 µF +80/-20%, 50 V, Ceramic Disc	020-380-9-001
C112	220 µF, 50 V, Electrolytic	022-328-9-006
C113	47 µF, 25 V, Electrolytic	022-328-9-001
C114	0.01 µF, 1000 V, Ceramic Disc	020-380-9-002
C201	0.01 µF +80/-20%, 50 V, Ceramic Disc	020-380-9-001
	DIODES	
BD101, 102	2W06, 2 Amp Diode Bridge	157-039-9-001
D101	5.1 Volt, 1/2 W, Zener Diode	152-112-9-001
D102	12 Volt, 1/2 W, Zener Diode	152-155-9-001
D103	1N4148 Diode	151-038-9-001
D104	5.6 Volt, 1/2 W, Zener Diode	152-072-9-001
D105, 106	1N4148 Diode	151-038-9-001
D107	12 Volt, 1/2 W, Zener Diode	152-155-9-001
D108	Green LED	158-069-9-002
D109	Red LED	158-069-9-001
D110, 111	1N4148 Diode	151-038-9-001
D112, 113	1N5402 Diode	151-136-9-001
D201	1N4148 Diode	151-038-9-001

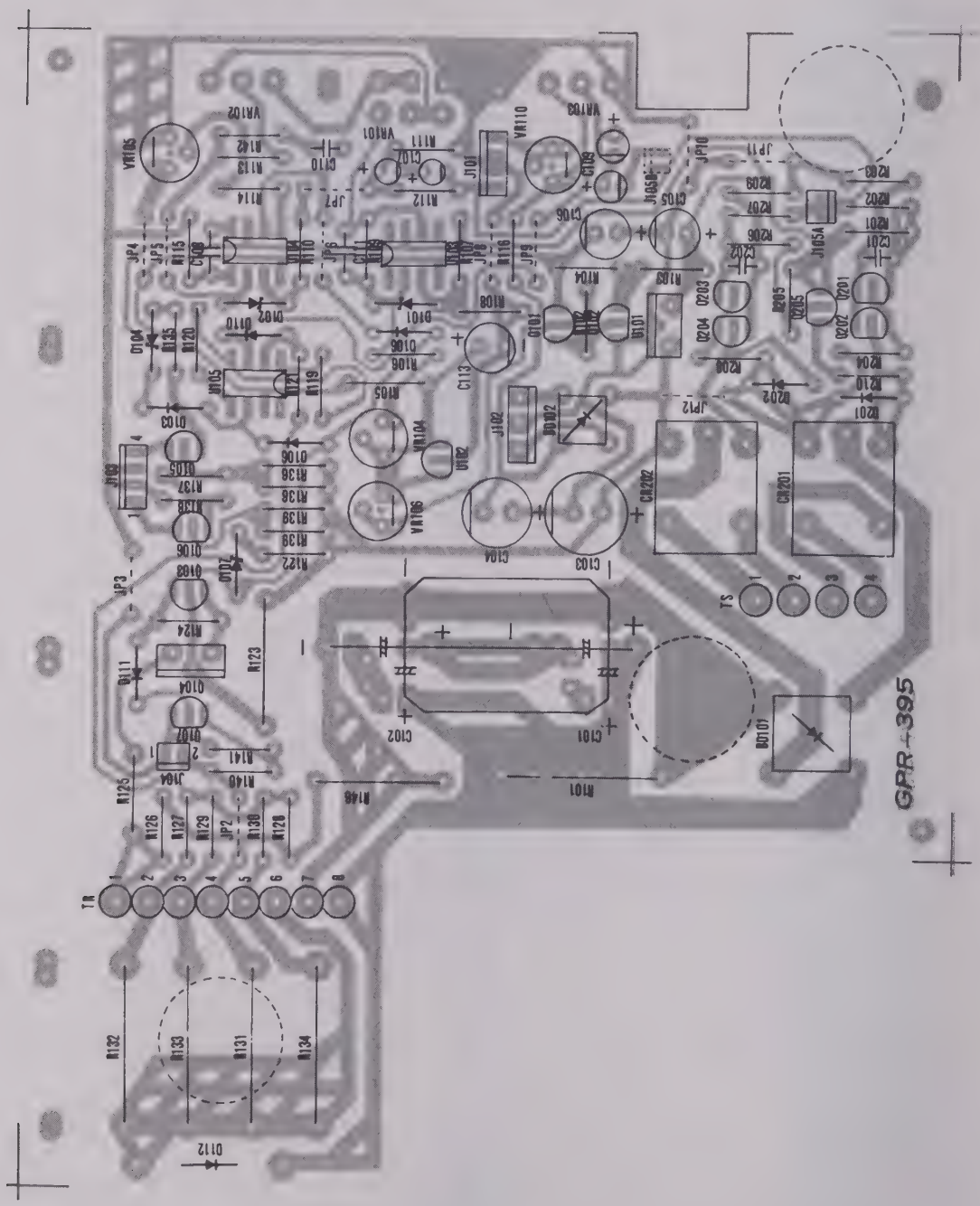
SCHEMATIC SYMBOL	DESCRIPTION	B&K-PRECISION PART NO.
	TRANSISTORS	
Q101	2SB564L, PNP Transistor	177-058-9-001
Q102	2SA1015GR, PNP Transistor	177-057-9-001
Q103	2SC1815GR, NPN Transistor	176-095-9-001
Q104	2SD313E, NPN Transistor	176-104-9-003
Q105-107	2SC1815GR, NPN Transistor	176-095-9-001
Q108	2N3055, NPN Power Transistor	172-033-9-001
Q201, 202	2SC1815GR, NPN Transistor	176-095-9-001
	INTEGRATED CIRCUITS	
U101	7815M, +15 Volt Regulator	307-081-9-001
U102	431CPL, Integrated Circuit	307-409-9-001
U103	741CP, Integrated Circuit	307-018-9-001
U104	301AP, Integrated Circuit	307-074-9-001
U105	741CP, Integrated Circuit	307-018-9-001
	MISCELLANEOUS	
CR201	Relay, 24 VDC	441-050-9-001
F101	Fuse, 1 Amp, 250 V, 3AG	191-251-3-001
	Fuseholder	742-052-9-001
S101	Rocker Switch (POWER)	093-014-9-001
S102	Slide Switch (HI-LO)	084-154-9-001
T101	Power Transformer	065-212-9-001
	Meter, Volts	320-137-9-001
	Meter, Current	320-139-9-001
	Knob, Gray (3 used)	751-312-9-001
	Top Cover	253-133-9-001
	Front Panel, Plastic	380-537-9-001
	Inlay, Control Panel	260-426-9-001
	Inlay, Model Number	260-428-9-001
	Binding Post, 3-Terminal (Red, Green, Black)	773-135-9-001
	Shorting Bar (Binding Post Strap)	261-195-9-001
	Rubber Foot	381-152-9-001
	Handle, Rubber Strap	746-076-9-001
	Handle, Steel Bar (thru rubber strap)	746-076-9-002
	Handle, End Cap (2 used)	746-076-9-003
	AC Line Cord	420-013-9-001
	Hook-Up Lead, Red	539-001-0-000
	Hook-Up Lead, Black	539-002-0-000
	Instruction Manual	480-492-9-001

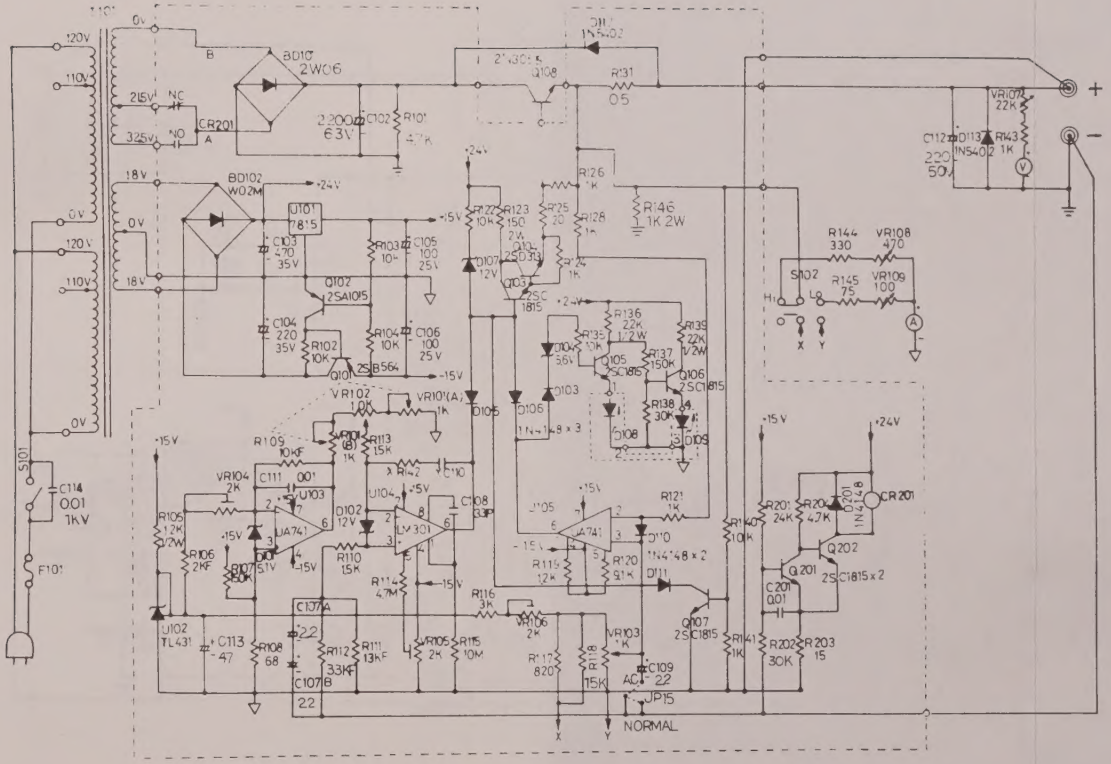
MODEL 1630

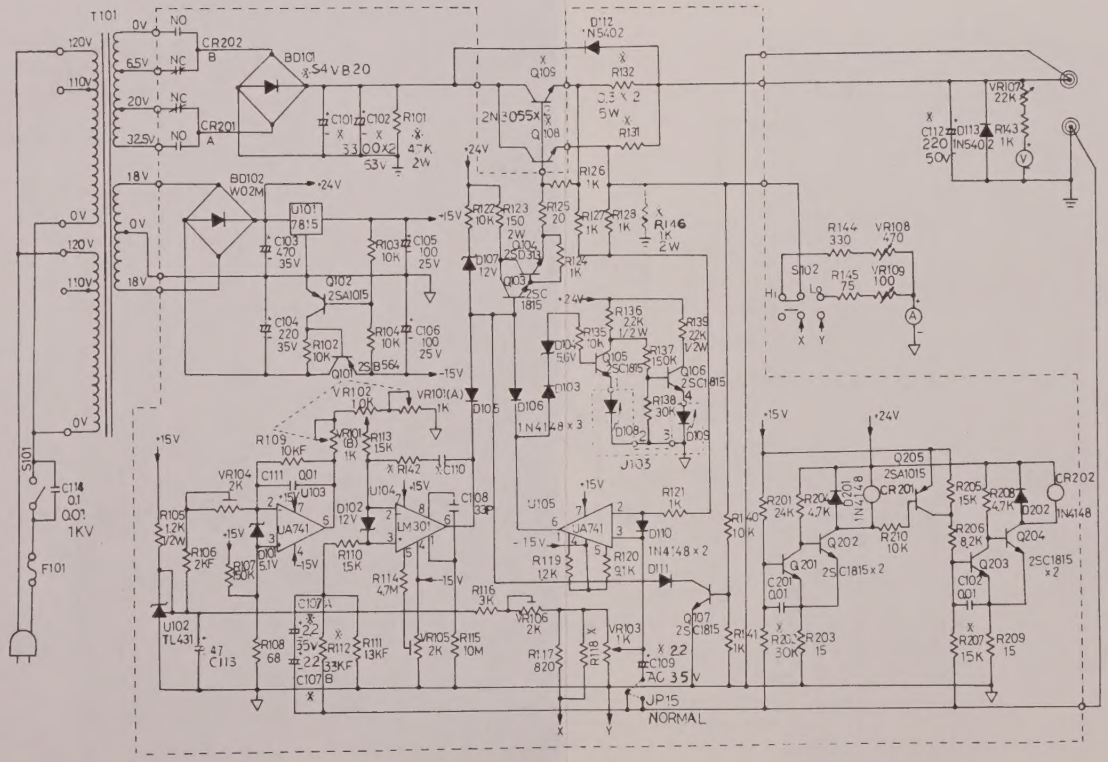
SCHEMATIC SYMBOL	DESCRIPTION	B&K-PRECISION PART NO.
	RESISTORS	
	Unlisted resistors are ±5%, 1/4 W or 1/2 W. See schematic diagram for value and wattage.	
R101	4.7 kΩ ±5%, 2 W, Metal Oxide	011-002-5-472
R106	2 kΩ ±1%, 1/4 W, Metal Film	015-144-2-001
R109	10 kΩ ±1%, 1/4 W, Metal Film	015-144-1-002
R111	13 kΩ ±1%, 1/4 W, Metal Film	015-144-1-302
R112	33 kΩ ±1%, 1/4 W, Metal Film	013-076-9-014
R123	150 Ω ±5%, 2 W, Wire Wound	006-002-5-151
R131, 132	0.3 Ω ±5%, 5 W, Wire Wound	004-221-9-001
R146	1 kΩ ±5%, 2 W, Metal Oxide	011-002-5-102
VR101	Dual 1 kΩ Potentiometer (FINE Control)	008-841-9-003
VR102	10 kΩ Potentiometer (COARSE Control)	008-841-9-002
VR103	1 kΩ Potentiometer (CURRENT Control)	008-841-9-001
VR104	2 kΩ Trimmer Pot	010-025-9-004
VR105, 106	2.2 kΩ Trimmer Pot	010-025-9-005
VR107	20 kΩ Trimmer Pot	010-025-9-003
VR108	470 Ω Trimmer Pot	010-025-9-002
VR109	100 Ω Trimmer Pot	010-025-9-001
	CAPACITORS	
C102	6800 µF, 63 V, Electrolytic	022-328-9-005
C103	470 µF, 35 V, Electrolytic	022-328-9-004
C104	220 µF, 35 V, Electrolytic	022-328-9-003
C105, 106	100 µF, 25 V, Electrolytic	022-328-9-002
C107A, 107B	2.2 µF ±10%, 35 V, Tantalum	027-074-9-001
C108	33 pF ±5%, 50 V, NP0, Ceramic Disc	031-066-9-001
C109	2.2 µF ±10%, 35 V, Tantalum	027-074-9-001
C111	0.01 µF +80/-20%, 50 V, Ceramic Disc	020-380-9-001
C112	220 µF, 50 V, Electrolytic	022-328-9-006
C113	47 µF, 25 V, Electrolytic	022-328-9-001
C114	0.01 µF, 1000 V, Ceramic Disc	020-380-9-002
C201, 202	0.01 µF +80/-20%, 50 V, Ceramic Disc	020-380-9-001
	DIODES	
BD101	S4VB20, 4 Amp Diode Bridge	157-002-9-001
BD102	W02M, 1 Amp Diode Bridge	157-038-9-001
D101	5.1 Volt, 1/2 W, Zener Diode	152-112-9-001
D102	12 Volt, 1/2 W, Zener Diode	152-155-9-001
D103	1N4148 Diode	151-038-9-001
D104	5.6 Volt, 1/2 W, Zener Diode	152-072-9-001
D105, 106	1N4148 Diode	151-038-9-001
D107	12 Volt, 1/2 W, Zener Diode	152-155-9-001
D108	Green LED	158-069-9-002
D109	Red LED	158-069-9-001
D110, 111	1N4148 Diode	151-038-9-001
D112, 113	1N5402 Diode	151-136-9-001
D201, 202	1N4148 Diode	151-038-9-001

SCHEMATIC SYMBOL	DESCRIPTION	B&K-PRECISION PART NO.
	TRANSISTORS	
Q101	2SB564L, PNP Transistor	177-058-9-001
Q102	2SA1015GR, PNP Transistor	177-057-9-001
Q103	2SC1815GR, NPN Transistor	176-095-9-001
Q104	2SD313E, NPN Transistor	176-104-9-003
Q105-107	2SC1815GR, NPN Transistor	176-095-9-001
Q108, 109	2N3055, NPN Power Transistor	172-033-9-001
Q201-204	2SC1815GR, NPN Transistor	176-095-9-001
Q205	2SA1015GR, PNP Transistor	177-057-9-001
	INTEGRATED CIRCUITS	
U101	7815M, +15 Volt Regulator	307-081-9-001
U102	431CPL, Integrated Circuit	307-409-9-001
U103	741CP, Integrated Circuit	307-018-9-001
U104	301AP, Integrated Circuit	307-074-9-001
U105	741CP, Integrated Circuit	307-018-9-001
	MISCELLANEOUS	
CR201, 202	Relay, 24 VDC	441-050-9-001
F101	Fuse, 3 Amp, 250 V, 3AG	191-251-3-003
	Fuseholder	742-052-9-001
S101	Rocker Switch (POWER)	093-014-9-001
S102	Slide Switch (HI-LO)	084-154-9-001
T101	Power Transformer	065-211-9-001
	Meter, Volts	320-137-9-001
	Meter, Current	320-138-9-001
	Knob, Gray (3 used)	751-312-9-001
	Top Cover	253-133-9-001
	Front Panel, Plastic	380-537-9-001
	Inlay, Control Panel	260-426-9-001
	Inlay, Model Number	260-427-9-001
	Binding Post, 3-Terminal (Red, Green, Black)	773-135-9-001
	Shorting Bar (Binding Post Strap)	261-195-9-001
	Rubber Foot	381-152-9-001
	Handle, Rubber Strap	746-076-9-001
	Handle, Steel Bar (thru rubber strap)	746-076-9-002
	Handle, End Cap (2 used)	746-076-9-003
	AC Line Cord	420-013-9-001
	Hook-Up Lead, Red	539-001-0-000
	Hook-Up Lead, Black	539-002-0-000
	Instruction Manual	480-492-9-001

CIRCUIT BOARD MAP




120V
110V
0V
18V
BD101
2W06
BD102
W02M
U101
78'S
U102
TL431
Q101
2SB564
Q102
2SA1015
Q103
2SD313
Q104
2SC1815
Q105
2SC1815
Q106
2SC1815
Q107
2SC1815
Q108
2SC1815
Q201
2SC1815 x 2
Q202
2SC1815 x 2
U103
UA741
U104
LF 351
U105
UA741
D101
1N5402
D102
12V
D103
5.6V
D104
1N4148 x 3
D105
D106
1N4148 x 3
D107
12V
D108
D109
D110
1N4148 x 2
D111
D112
1N5402
D113
1N5402
D201
1N4148
CR201
CR202
VR101
22K
VR102
100
VR103
1K
VR104
2K
VR105
2K
VR106
2K
VR107
22K
VR108
470
VR109
100
S101
S102
F101
C114
001
1KV
C102
2200
63V
C103
470
35V
C104
220
35V
C105
100
25V
C106
100
25V
C107A
22
C107B
22
C108
C109
22
C110
C111
001
C112
220
50V
C113
47
C201
001
R101
4.7K
R102
10K
R103
10K
R104
10K
R105
1.2K
2W
R106
2K
R107
51K
R108
68
R109
10K
R110
15K
R111
13K
R112
33K
R113
15K
R114
47M
R115
10M
R116
3K
R117
820
R118
15K
R119
12K
R120
91K
R121
1K
R122
10K
R123
150
2W
R124
1K
R125
20
R126
1K
R127
05
R128
1K
R131
R135
10K
R136
22K
1/2W
R137
150K
R138
30K
R139
22K
1/2W
R140
10K
R141
1K
R142
R143
1K
R144
330
R145
75
R146
1.1K 2W
R201
24K
R202
30K
R203
15
R204
47K
JP15
NORMAL
+
-
+15V
+24V
-15V
+5V


T101
120V
110V
0V
6.5V
20V
32.5V
18V
CR202
CR201
BD101
S4VB20
BD102
W02M
U101
7815
Q102
2SA1015
Q101
2SB564
Q103
2SC1815
Q104
2SD313
Q105
SC1815
Q106
2SC1815
Q107
2SC1815
Q108
2N3055
D112
1N5402
D113
1N5402
D107
12V
D104
5.6V
D105
D106
1N4148 x 3
D108
D109
D102
12V
D101
5.1V
D110
1N4148 x 2
D111
U102
TL431
U103
UA741
U104
LM301
U105
UA741
S101
F101
S102
VR101(A)
VR101(B)
VR102
VR103
VR104
VR105
VR106
VR107
VR108
VR109
JP15
NORMAL
Q201
2SC1815 x 2
Q202
2SC1815 x 2
Q203
2SC1815 x 2
Q204
2SC1815 x 2
Q205
2SA1015
D201
1N4148
D202
1N4148
+15V
-15V
+24V
X
Y
HI
LO
A
V

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